

SCC upgrade

~ Superconducting Accelerating Cavity ~

KEKB-MAC2005

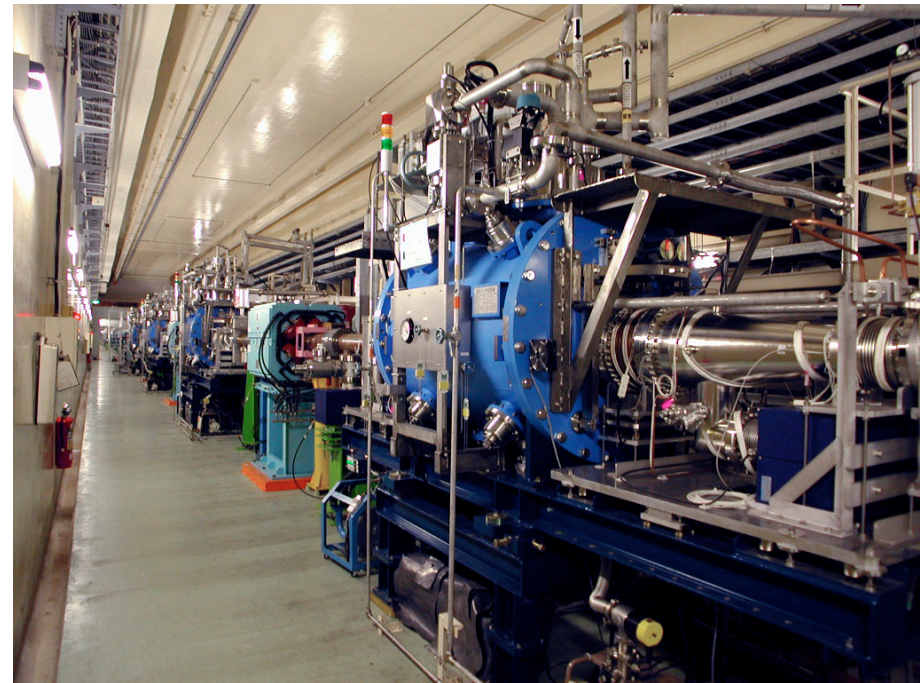
Feb. 22, 2005

T. Furuya

- The peak luminosity of KEBB has reached 150% of the design value.
- The beam intensity of HER reached 115%.

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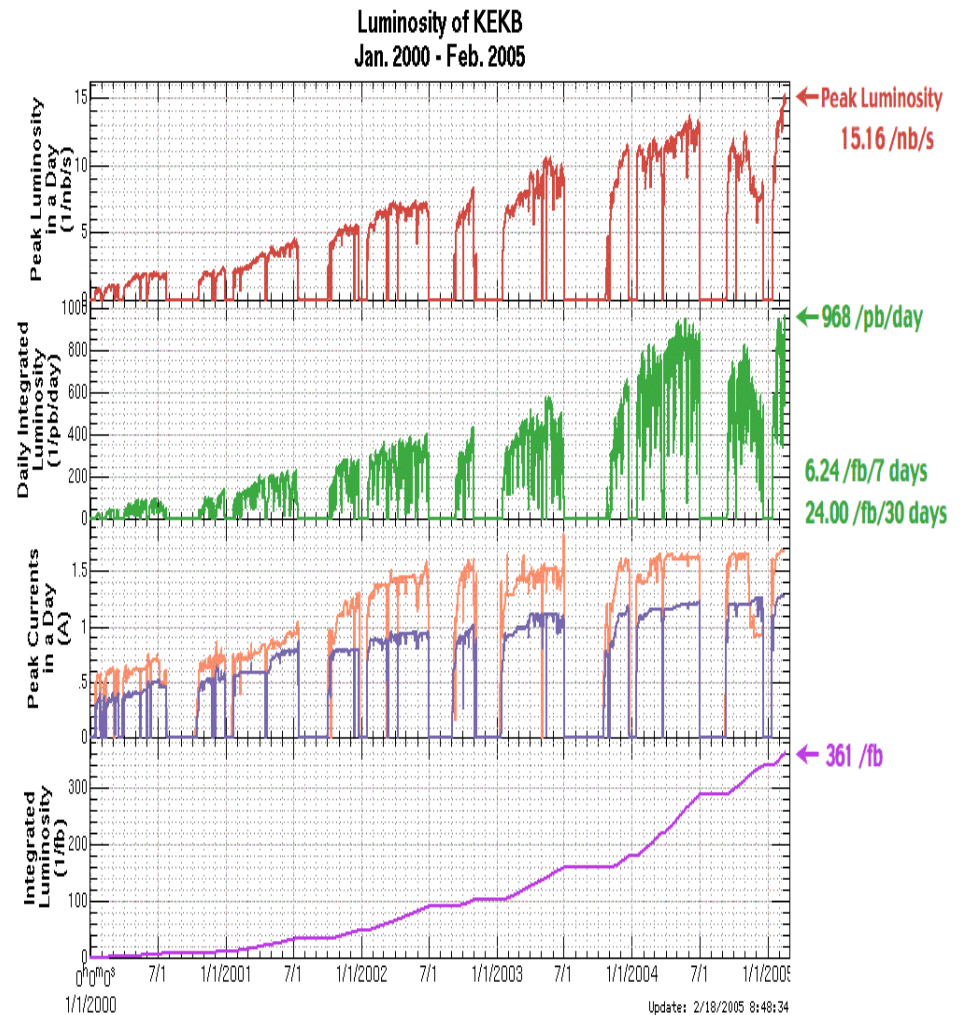
- 1) Achievements of KEBB-SC
- 2) Activity for upgrading



Achievements of KEKB-SC

Historical aspects

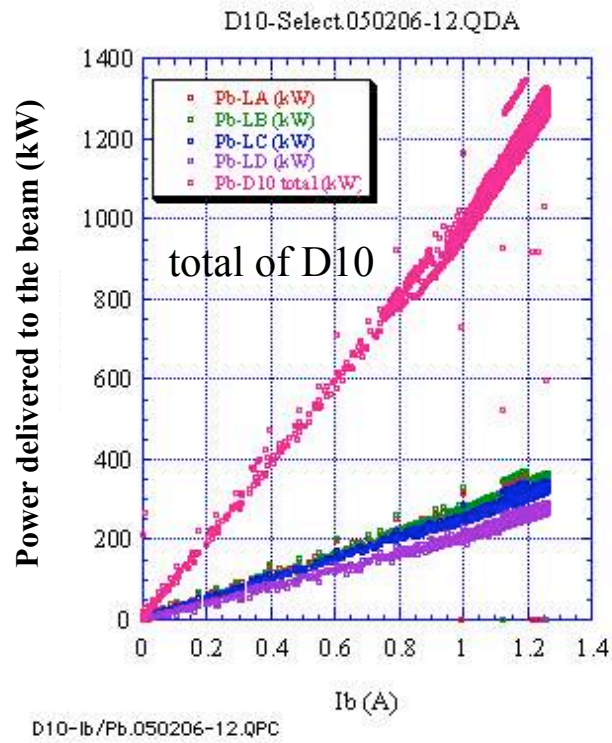
- 1998 Commissioning with 4 SC's in D11-site.
- 1999 Coupler power test: **380kW** to the beam.
Physics run start.
- 2000 Installation of the next 4-cavities in D10-site.
- 2001 $L_{\text{peak}} = 6.9 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$
with beams of HER/LER = **0.8A/1.0 A**.
HOM of each SC reached **5kW**.
- 2002 $L_{\text{peak}} = 8.2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$.
Beam of HER reached **1 A**.
- 2003 $L_{\text{peak}} = 1.06 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
The max. current of HER reached **1.1 A** in
1184 bunches.
HOM of each SC reached **10kW**.
- Capacity of cooling water was increased
to **20kW**.
SC-Vc test **up to 2MV** using D11B cavity.
 $L_{\text{peak}} = 1.13 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
with beams of HER/LER = **1.18A/1.56 A**
- 2004 **Continuous Injection mode**
1.25A in 1293 bunches induced **16kW** of HOM.
- 2005 $L_{\text{peak}} = 1.5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ with **1.27A(HER)**
.... still growing up



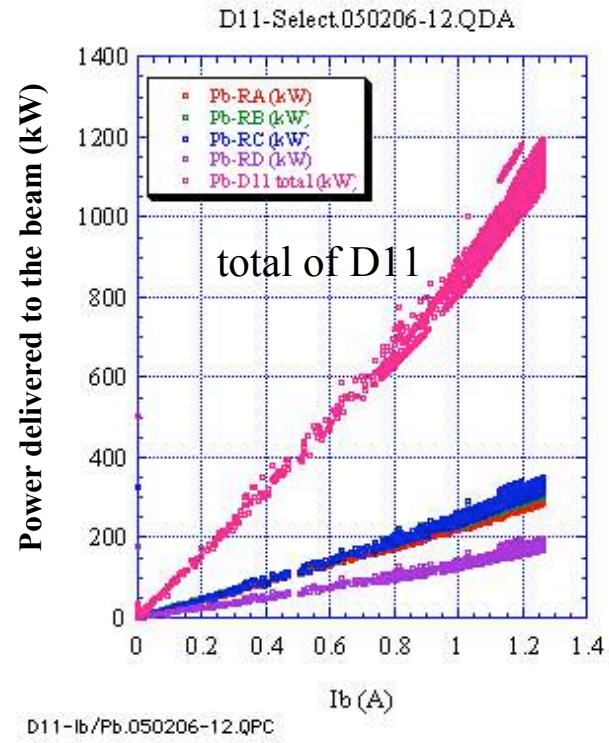
Achievements of KEBB-SC

RF power at 1.27 A

-RF power of 2.4 MW was transferred to the beam by 8 SC cavities.



D10 cavities

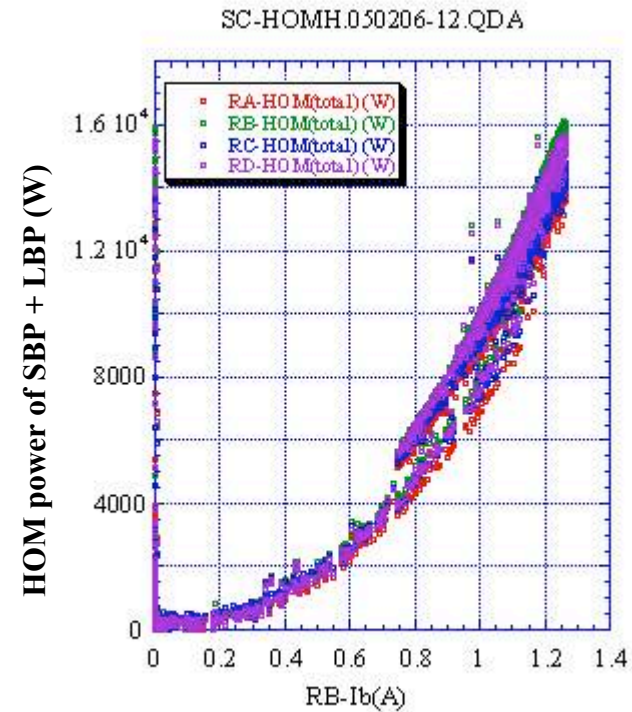
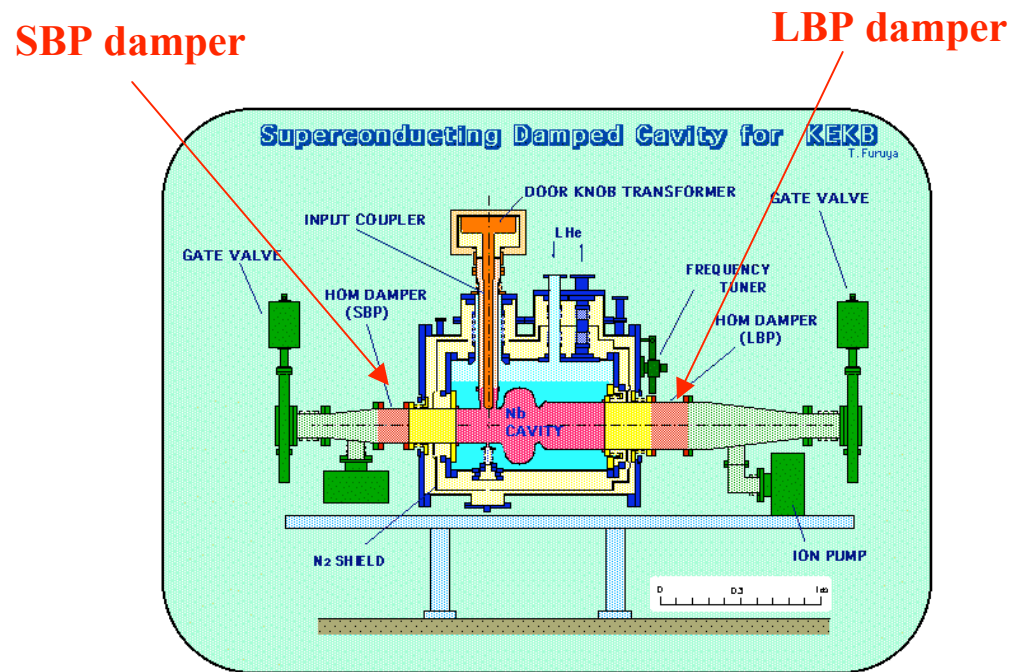


D11 cavities

Achievements of KEBB-SC

RF power absorbed by HOM dampers at 1.27 A

- A beam of 1.27 A in 1293 bunches induces the HOM of 14 - 16 kW for each module. ($\sigma_z=7\text{mm}$)
- The ratio of SBP / LBP is 7 kW / 9 kW.



D11-Ib/HOM.050206-12.QPC

HOM of D11 cavities

Achievements of KEBB-SC

Summary of figures

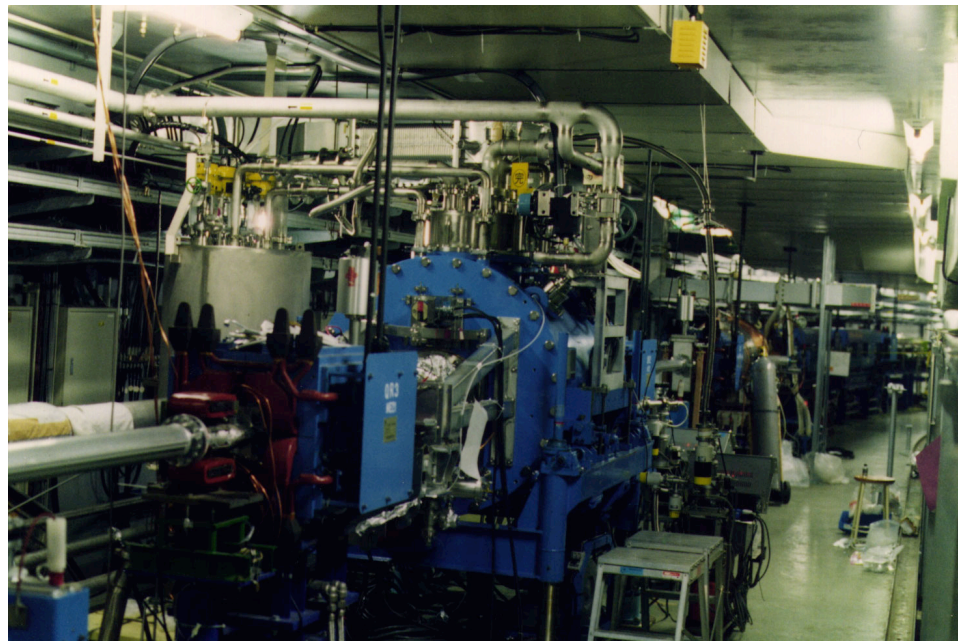
	design	achieved
Number of SC cavities	8	4 at the commissioning 8 since Set. 2000
Beam intensity	1.1A in 5000 bunches	1.27 A in 1293 bunches
Bunch length	4 mm	6 - 7 mm
Max RF voltage w/o beam	-	> 2.5 MV/cavity (2 – 2.8 MV/cavity)
RF voltage with beam	1.5 MV/cavity	1.2 – 2 MV/cavity
Q-value	1×10^9 at 2 MV	$0.5 - 2 \times 10^9$ at 2 MV
RF power transferred to the beam	> 250 kW/cavity	300 - 350 kW/cavity 400 kW/cavity in max.
HOM power	5 kW at 1.1 A	14 - 16 kW at 1.27 A

Activity for upgrading

1. Spare module

- * Because of the increase of a beam current, the SC system has no margin of RF power.
- * A prototype module constructed for the beam test in 1996 was modified as a spare module of KEBK in the last summer.
- * The module will be cooled at a test stand soon.

Prototype module in TRISTAN AR.



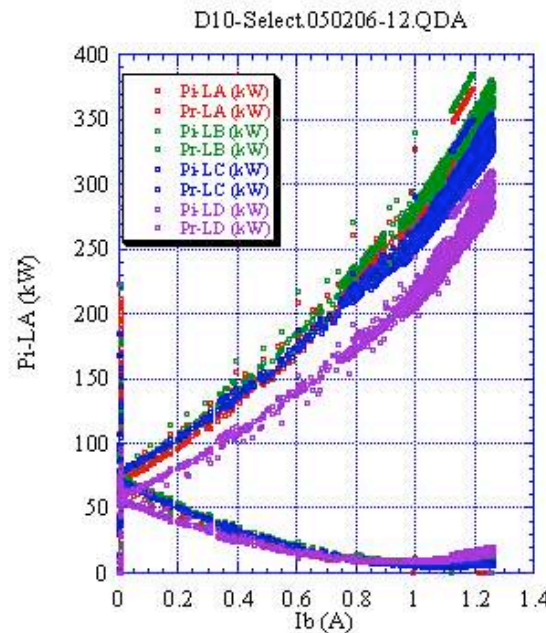
Activity for upgrading

2. Input coupler

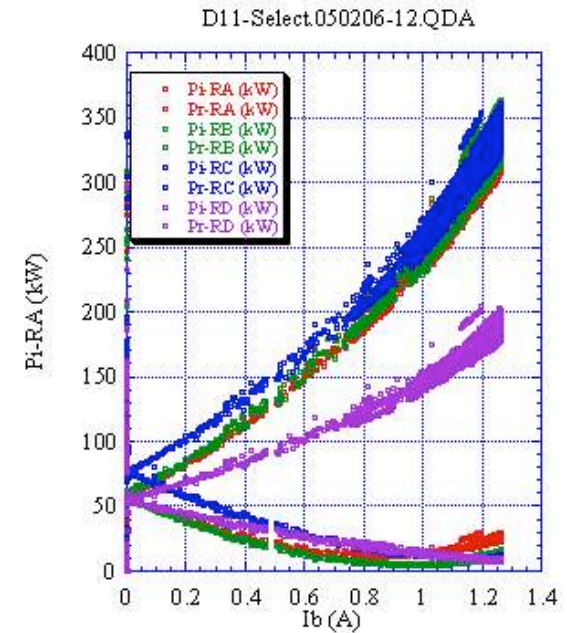
- * Required RF power in SuperKEKB is 460 kW/cavity.
- * Traveling wave of 500 kW was successfully supplied at a test stand in 2003.
- * To increase the coupling strength, the vacuum gasket of the outer conductor was replaced to thin one in the last summer shutdown.

- Qext of 5×10^4
D10A, D10B, D10C
D11C

- Qext of 7×10^4
D10D
D11A, D11B, D11D



D10-Ib/Pi,Pr.050206-12.QPC

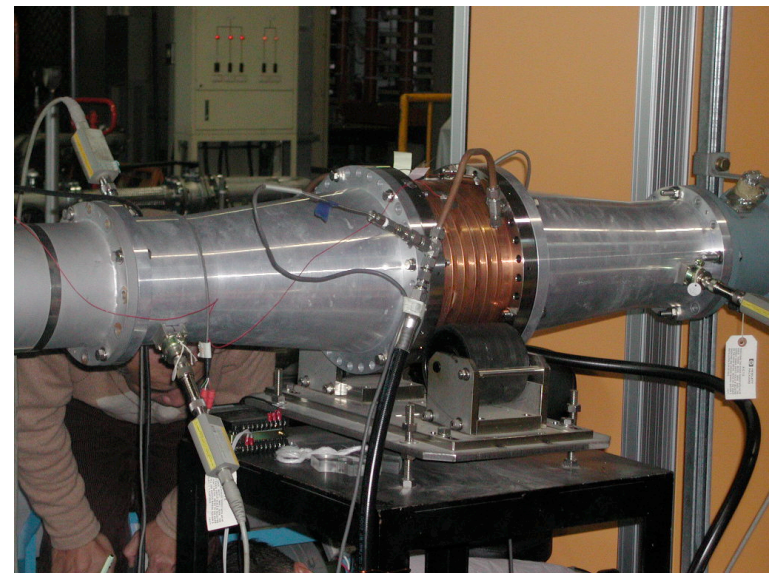
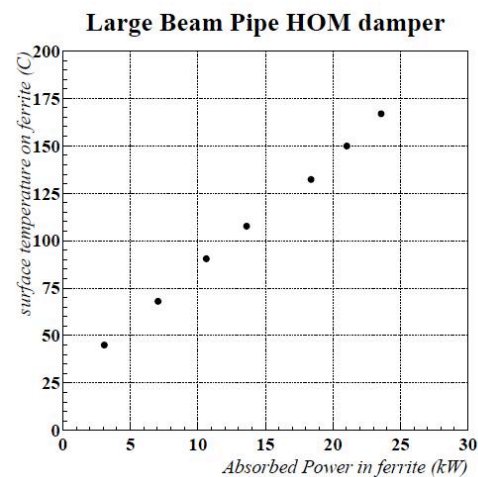
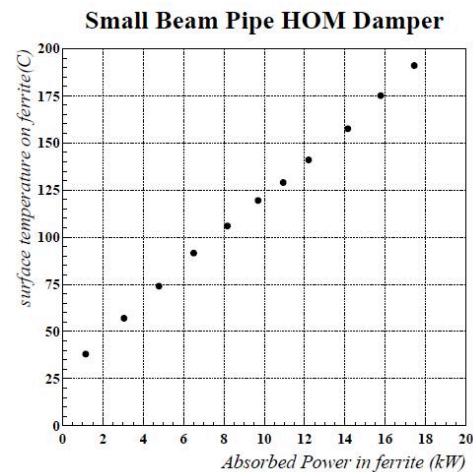


D11-Ib/Pi,Pr.050206-12.QPC

Activity for upgrading

3. Power test of a HOM damper

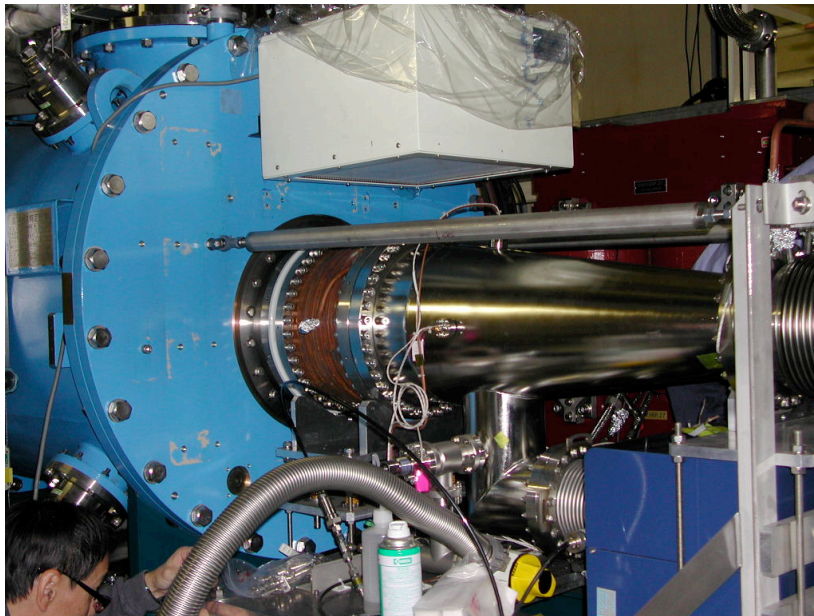
- * Power test was carried out to the spare dampers of SBP and LBP.
- * Absorbed power up to 18 kW for SBP damper and 25 kW for LBP damper did not damage the ferrite surface, which correspond to the HOM power at 2 A in 1300 bunches in HER.
- * The surface temperature reached near 200C.
- * Out gas rate should be measured as the next step.
- * In SuperKEKB, the HOM of 60 kW has to be absorbed by a pair of the dampers.
To reduce the temperature rise of the surface, the dampers with a thin ferrite cylinder (2-3 mm) will be fabricated and tested.



Activity for upgrading

4. HOM damper trouble: vacuum leakage of the D11A-LBP damper

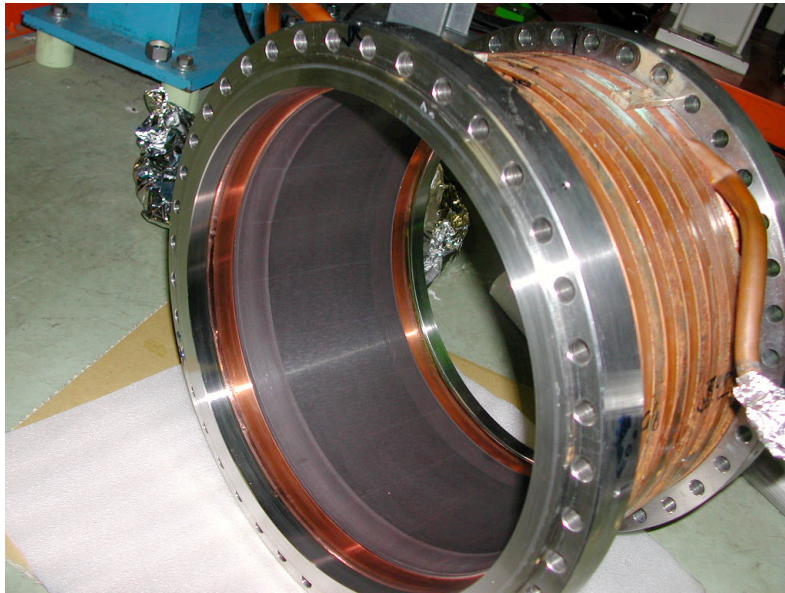
- * At the end of the last year, one of the HOM damper had a vacuum leakage at a welding seam of the flange. (D11A-LBP)
- * Troubled damper was replaced to new one in this winter shutdown.



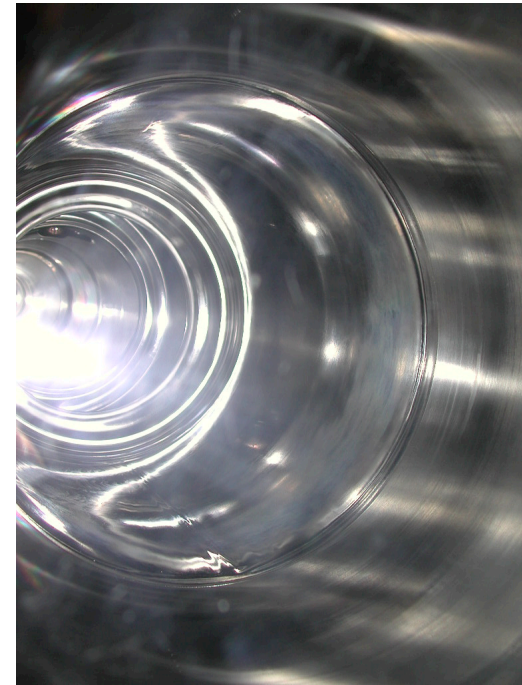
Troubled damper was replaced to new one in the tunnel.

Activity for upgrading

- * During replacement of the dampers, we could inspect the ferrite surface.
- * No damage or cracking was observed on both SBP and LBP dampers.



Vacuum leakage happened at EB-welding
between SUS and Cu.

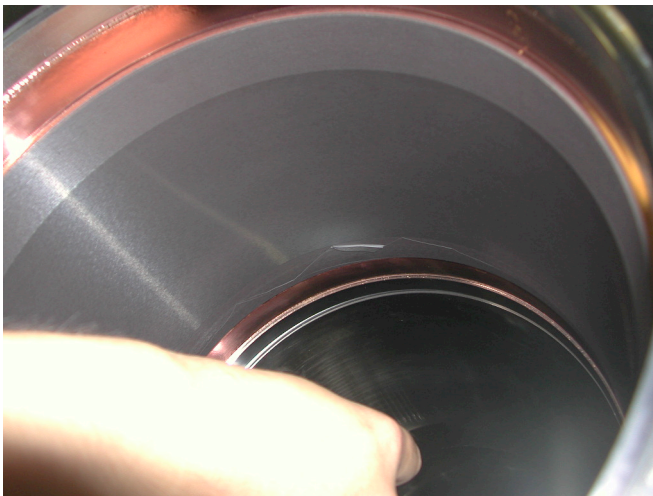


Inside view of the D11A cavity

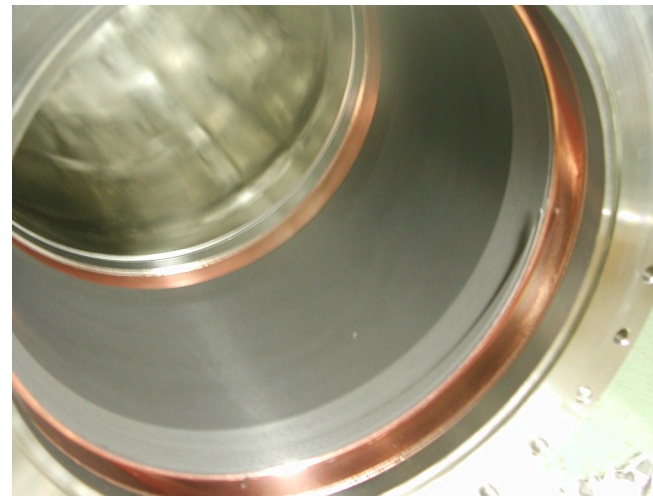
Activity for upgrading

5. Cracking of HOM damper in CRAB-dummy chambers

- * Both SiC and ferrite absorbers had been installed in crab-dummy chambers of D01-section and D02-section in Tsukuba-area.
- * The damage of these dampers were found in October and December.
- * Ferrite size: 170 mm ferrite cylinder with the diameter of 240 mm.



Ferrite damper of D01 section.



Ferrite damper of D02 section.

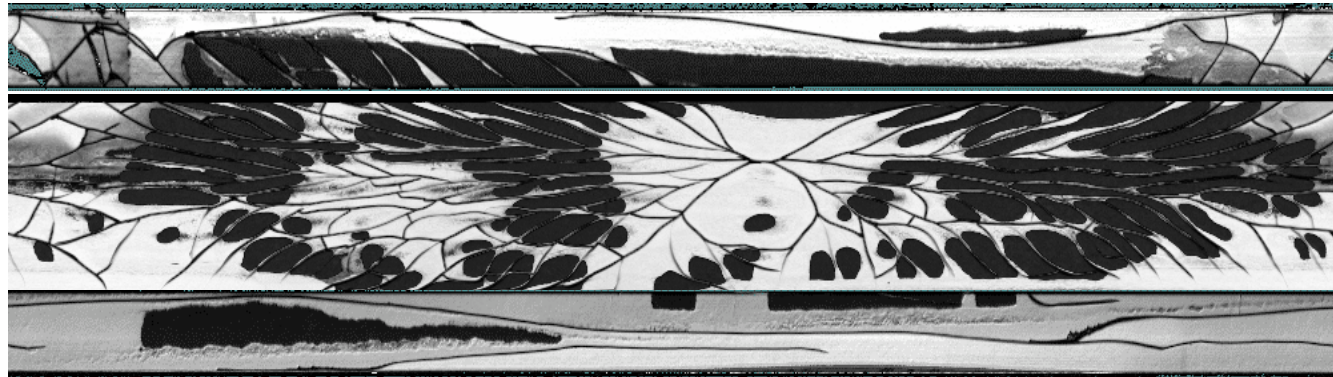
Activity for upgrading

..... as a preliminary results.....

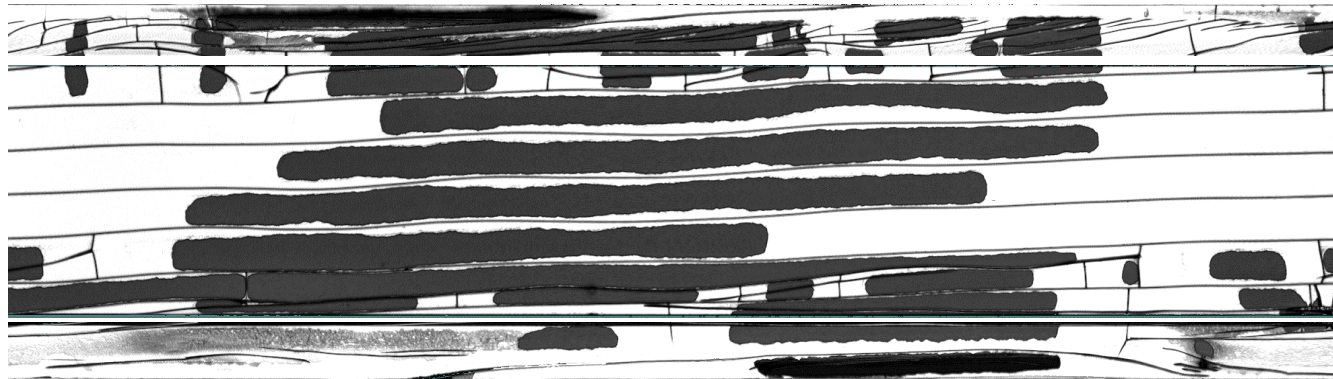
Both simulation of loss factor and temperature measurements showed the absorbed power of only 4 kW at the maximum beam intensity.

Ultra-sonic scanning showed a lot of cracking of the ferrite.

D01 ferrite



D02 ferrite



Spiral cracking suggests that caused by winding of cooling pipe from the out side.

6. Summary

- * Beam intensity of HER has increased to 1.27 A.
- * SC cavities can provide the voltage of 1.4 MV/cavity and 300 – 350 kW/cavity to the beam of 1.27 A.
- * Coupling of the input coupler has been increased on 4 cavities. ($7 \times 10^4 \rightarrow 5 \times 10^4$)
- * The HOM absorbed by the damper reached 16 kW/cavity.
 - SBP / LBP = 7 kW / 9 kW
 - No damage was observed on the dampers of D11A cavity.
- * Power test at a test stand showed no damage of the ferrite surface up to 18 kW for SBP damper and 25 kW for LBP damper, which correspond to the HOM power at 2 A in HER.
- * Cracking of the D02-ferrite suggest the improvement of the damper fabrication process should be established.